

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
18 May 2006 (18.05.2006)

PCT

(10) International Publication Number
WO 2006/052491 A2

(51) International Patent Classification:
F16B 37/04 (2006.01)

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EH, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SI, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(21) International Application Number:
PCT/US2005/039128

(22) International Filing Date: 31 October 2005 (31.10.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/625,094 5 November 2004 (05.11.2004) US
11/163,685 27 October 2005 (27.10.2005) US

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(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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Published:

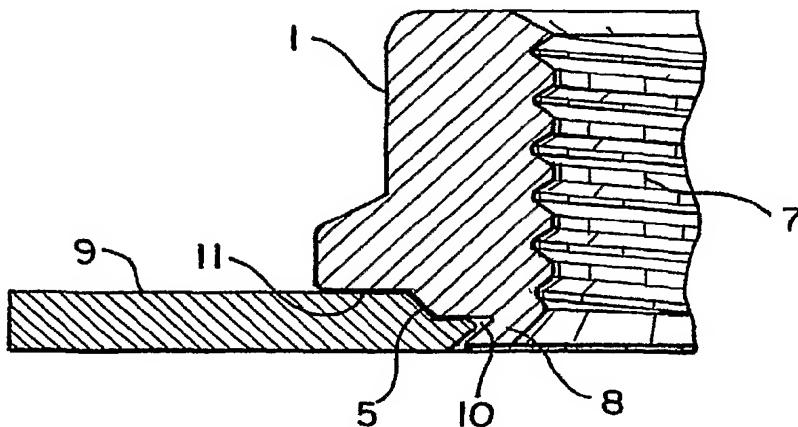
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— without international search report and to be republished upon receipt of that report

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ROTATABLLE CAPTIVATED NUT



(57) Abstract: A captive clinch nut may be rotatably attached to an apertured sheet. The nut includes a body having an axial threaded bore and a flange forming a base of the nut body. The flange includes a surface on a bottom side thereof preferably unitary therewith for providing a bearing surface of reduced friction against the sheet. A displacer unitary with the nut body is located directly below the flange and has an outside diameter less than an outside diameter of the flange. A tubular flared shank unitary with the nut body extends coaxially from the displacer, and includes a neck immediately adjacent the displacer with

an outside diameter less than the outside diameter of the displacer forming an undercut area between the outside of the shank and an underside of the displacer for receiving the cold flow of metal of the sheet.

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1 ROTATABLE CAPTIVATED NUT

2

3 RELATED APPLICATIONS

4 The present application is related to provisional patent application serial
5 number 60/625,094 entitled "Rotatable Captivated Nut" filed on November 5,
6 2004, priority from which is hereby claimed.

7 FIELD OF THE INVENTION

8 The present invention relates to fasteners which are captivated in a sheet of
9 material yet are free to rotate so that they may engage another member. More
10 specifically, it relates to a tool- rotatable captivated fastener which is captivated by
11 a sheet of metal which is deformed during the clinch attachment process.

12 BACKGROUND OF THE INVENTION

13 There is a need in the fastening industry for a nut that is captive similar to
14 existing clinch nuts, but may still be turned to engage a screw or bolt to provide a
15 clamp load. In one case, this is needed so that a captive and stationary stud can be
16 used in conjunction with a captive nut. This allows both mating components, the
17 stud and the nut, to be captive in a sheet. The benefit of the captive components
18 include elimination of loose hardware, reduction of BOM inventories, ease of
19 manufacturing and assembly and cost reductions.

20 It is known to provide a captive rotatable nut in a sheet by flaring the shank
21 of the nut within a washer on the opposite side of the sheet as shown for example
22 in U.S. Patent 6,866,456. This configuration, however, requires a specialized anvil
23 to be located on the opposite side of the sheet and a clamp load cannot be applied
24 directly to the back side of the sheet because of the presence of the washer. Also,

1 simple stake nuts are known that include an extending shank which is deformed
2 against the back side of the sheet. This also requires a second installation
3 component, i.e. an anvil, and does not provide a flush attachment. The present
4 invention solves the problems posed by these undesirable characteristics of the
5 prior art.

6 **SUMMARY OF THE INVENTION**

7 The device is a clinching nut without an anti-torque feature unlike the prior
8 art which includes sheet-gripping structures to provide rigid attachment. The
9 shank of the clinch nut includes a displacer and an undercut, but no anti-torque
10 features such as knurl-type serrations are included. In this regard, a smooth
11 surfaced shank extends from a flange of the nut. The flange provides a bearing
12 surface that is free of projections and irregularities that could impair the rotation of
13 the nut or disturb the surface of the substrate. The head of the nut may be of any
14 shape. A hex is recommended as a convenient nut shape because of the
15 commonality of the design. A standard hex shape above the flange allows common
16 wrenches and sockets to engage and turn the nut, however other shapes may also
17 be applied. For example a circle with two flats, an acorn nut, or a more exotic
18 shape could be utilized. The height of the head should be sufficient to provide the
19 desired nut strength. Material choice of the nut is important for the design to
20 function correctly. Because the part must clinch, the hardness of the part must be
21 sufficient to cause yielding of the substrate panel. These issues are common with
22 other clinching fasteners and should be apparent to one skilled in the art.

23 More specifically, the applicant has devised a captive clinch nut for
24 rotatable attachment to an apertured sheet comprising a nut body having an axial

1 threaded bore, and a flange forming a base of the nut body. The flange includes a
2 surface on a bottom side thereof preferably unitary therewith for providing a
3 bearing surface of reduced friction against the sheet. A displacer unitary with the
4 nut body is located directly below the flange and has an outside diameter less than
5 an outside diameter of the flange. A tubular flared shank unitary with the nut body
6 extends coaxially from the displacer, and includes a neck immediately adjacent the
7 displacer with an outside diameter less than the outside diameter of the displacer
8 forming an undercut area between the outside of the shank and an underside of the
9 displacer for receiving the cold flow of metal of the sheet. The outer surfaces of
10 the displacer and the shank are of reduced friction for providing a bearing surface
11 of the nut against the inside wall of the aperture in the sheet. The side surface of
12 the displacer is preferably tapered inwardly. The captive nut is used with a sheet
13 wherein the displacer and shank of the nut body are located within the sheet and
14 are coaxial with the aperture such that a portion of the sheet lies within an undercut
15 area located between the bottom of the displacer and the outside surface of the
16 shank. A space between the outside surfaces of the displacer and the flange and an
17 inside wall of the sheet aperture is such that the nut is freely rotatable within the
18 sheet while being secured against substantial axial displacement therefrom.
19 Preferably, the width of the displacer and the length of the shank are less than the
20 thickness of the sheet such that the shank does not extend beyond a back side
21 surface of the sheet. The nut is used with a relatively ductile sheet material such
22 that the flange remains relatively non-deformable and is composed of a material
23 having a hardness substantially greater than that of the sheet.

24 From the following drawings and description of the preferred embodiment,

1 it will be appreciated by those of skill in the art that the objects of the invention
2 have been achieved. While the present invention will be described with the
3 reference to a specific embodiment, the following description is illustrative of the
4 invention and is not to be construed as limiting the invention. Various
5 modifications to the present invention can be made to the preferred embodiment by
6 those skilled in the art without departing from the true spirit and scope of the
7 invention. It will be noted here that for better understanding like components are
8 designated by the reference numerals throughout the various figures of drawing
9 which follow.

10 **DESCRIPTION OF THE DRAWINGS**

11 Figure 1 is a front view of the invention.

12 Figure 2 is a bottom isometric view.

13 Figure 3 is an elevation partial section view.

14 **DESCRIPTION OF THE PREFERRED EMBODIMENT**

15 Referring now to Figure 1, the fastener of the invention is in the form of a
16 nut including a head 1 which includes tool-engaging flats 2 for applying a rotational
17 torque to the nut. A hexagonal configuration is preferred for the tool-engaging
18 surfaces. The nut further includes a flange 3 which has a smooth bottom face 11
19 which serves as a first bearing surface against a sheet (shown in Figure 3) into
20 which the nut is installed. The nut is installed by the clinch process in which a
21 lower shank portion 8 is provided with a displacer 5 and an undercut 6. The
22 displacer is tapered inwardly. The shank of the nut is placed through an aperture in
23 the sheet, and when the nut is pressed into a sheet of sufficiently ductile material,
24 the displacer forces a cold flow of sheet material into the undercut area 6, thus

1 attaching the nut to the sheet.

2 As shown in Figure 2, undercut feature **6** which begins at a neck of said
3 shank lies immediately below said displacer **5**. Internal threads of the nut **7** extend
4 the entire length of the nut. Tubular shank **8** and the outer surface of displacer **5**
5 are smooth surfaced and are of reduced friction to enhance their function as
6 bearing surfaces in addition to the bottom face **11** of the nut flange **3**.

7 Referring now to Figure 3, the nut is installed in a sheet **9** which has an
8 aperture diameter and thickness sized in relation to the dimensions of the nut
9 shown in Figures 1 and 2 such that the cold flow of metal of the sheet is not tightly
10 compressed against the outer surfaces of the displacer or the flange. Space **10**
11 between the sheet and the nut enables the nut to freely rotate within the sheet **9**
12 while providing significant pull-out resistance due to the cold flow of material of
13 the sheet located within the undercut area between the flared shank **8** and the
14 displacer **5**. Bottom face **11** of flange **3** bears against the top surface of sheet **9** and
15 surface **11** is a smooth surface of reduced friction to enhance its performance.

16 It should be understood that there may be other modifications and changes
17 to the present invention that will be obvious to those of skill in the art from the
18 foregoing description, however, the present invention should be limited only by the
19 following claims and their legal equivalents.

CLAIMS

2 What is claimed is:

3 1. A captive clinch nut for rotatable attachment to an apertured sheet,
4 comprising:

5 a nut body having an axial threaded bore;

6 a first bearing surface of reduced friction on a bottom side of said
7 nut body;

8

8 a displacer unitary with said nut body and located directly below
9 said bearing surface, the displacer having an outside diameter less than an outside
10 diameter of said flange;

13 wherein a neck of said shank immediately adjacent said displacer
14 includes an outside diameter less than the outside diameter of said displacer
15 forming an undercut area between the outside of said shank and an underside of
16 said displacer for receiving the cold flow of metal of said sheet.

17 2. The clinch nut of claim 1 further including a flange forming a base
18 of said nut body.

1 and an inside wall of said sheet aperture such that the nut is freely rotatable within
2 said sheet while being secured against substantial axial displacement therefrom.

3 4. The assembly of parts of claim 3 wherein the width of said displacer
4 and the length of said shank are less than the thickness of said sheet such that said
5 shank does not extend beyond a back side surface of said sheet.

6 5. The assembly of parts of claim 4 wherein said nut is composed of a
7 material having a hardness substantially greater than said sheet.

8 6. The assembly of parts of claim 5 wherein said flange is relatively
9 non-deformable.

10 7. The assembly of parts of claim 6 wherein the portion of said sheet
11 which lies within said undercut area is received therein by the cold flow of metal of
12 said sheet.

13 8. The clinch nut of claim 2 further including a head portion having
14 tool-engaging flats on its outer surface.

15 9. The clinch nut of claim 8 wherein said head is of hexagonal cross-
16 section.

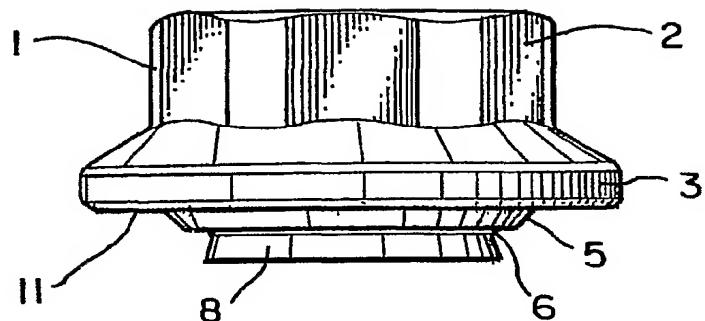
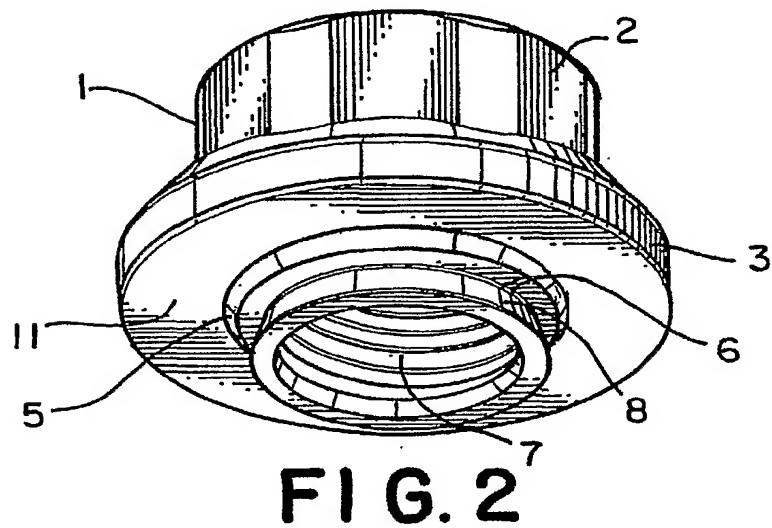
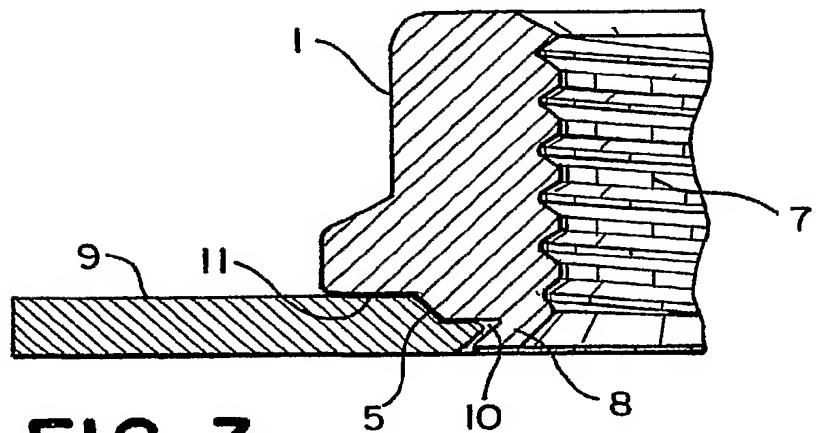
17 10. The clinch nut of claim 9 wherein said threaded bore extends
18 through the entire length of the nut.

19 11. The clinch nut of claim 1 wherein the outer surfaces of said
20 displacer and said shank are of reduced friction for providing bearing surfaces of
21 said nut against said sheet.

22 12. The clinch nut of claim 1 wherein said first bearing surface is
23 integral with said nut body.

24 13. The clinch nut of claim 1 wherein the displacer is tapered inwardly.

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**FIG. 1****FIG. 2****FIG. 3**

SUBSTITUTE SHEET (RULE 26)